CIRCULAR FAILURE

Lesson 7

LESSON 7 – ANALYSIS of CIRCULAR FAILURE

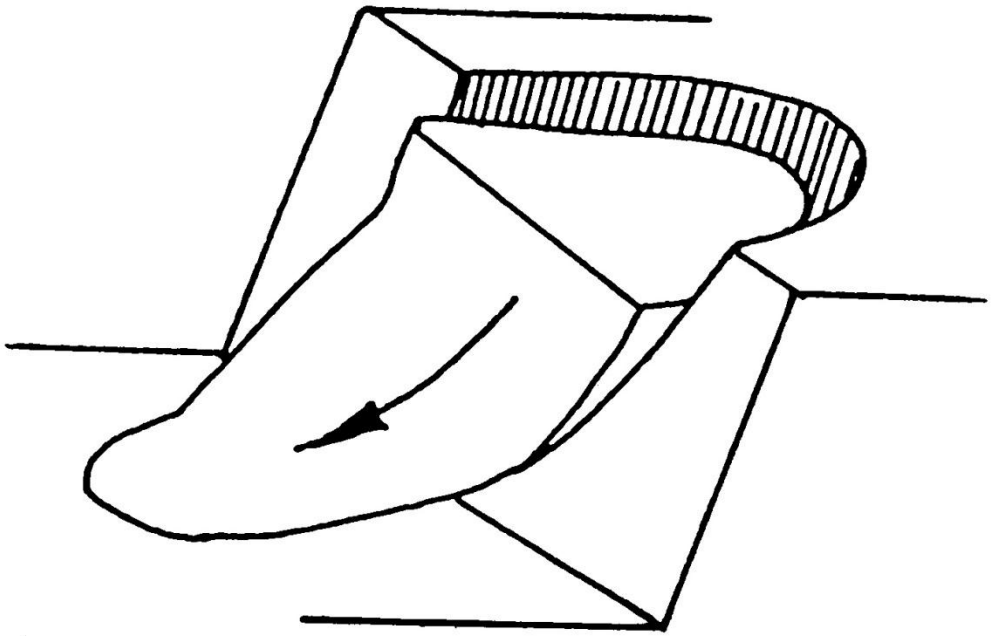
Learning Outcomes -

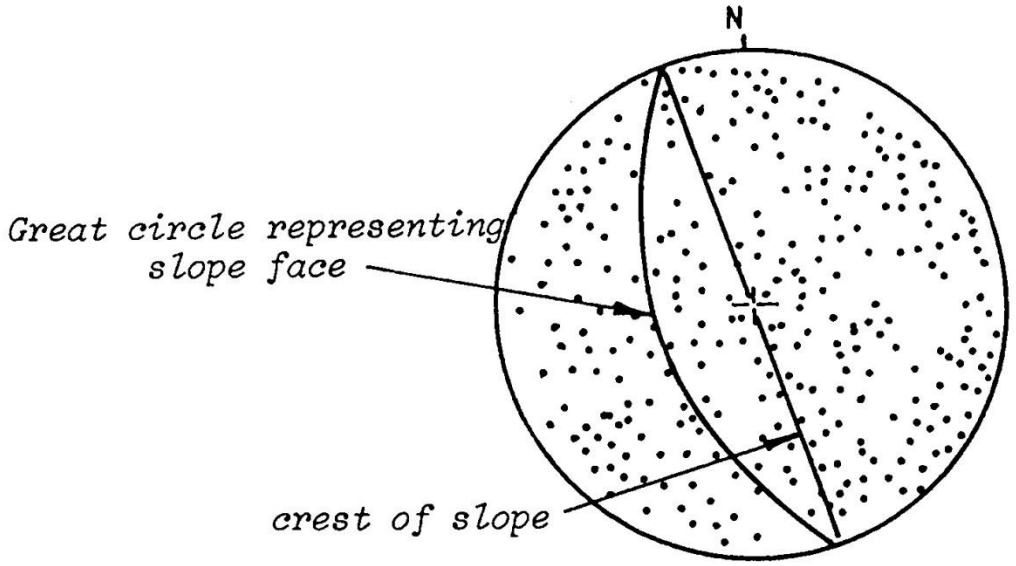
- ***Analyze structural geologic and slope geometric conditions using stereonets;***
- ***Analyze for Circular Failure using Design Charts;***
- ***Determine critical tension crack location and depth.***

Conditions for Circular Failure

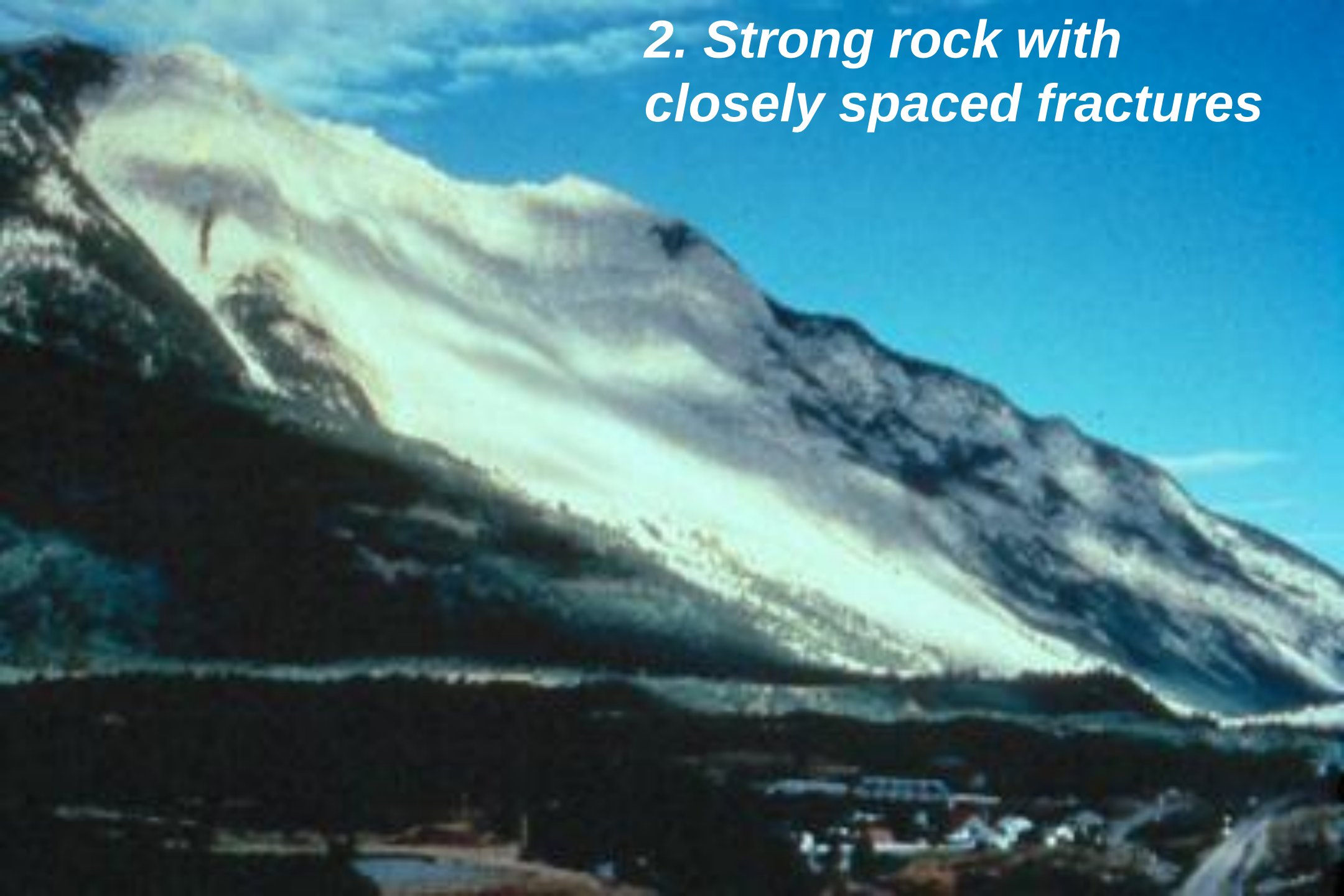
1. *Very Weak Rock with no Geologic Structure - e.g. Tuff*
2. *Strong Rock with Very Closely Spaced, Randomly Oriented Discontinuities*
3. *Highly Weathered Rock with no Significant Remnant Structure*
4. *Rock Fill - Clean, Strong Rock Fragments*

Stereoplot of Circular Failure






1. Very weak rock
with no structure


2. Strong rock with
closely spaced fractures

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3. Highly weathered rock with little remnant structure

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4. Rock Fill – waste dumps embankments

Circular Failure - Factor of Safety

- *Factor of Safety, F*

$$F = \frac{\text{shear strength available to resist sliding}}{\text{shear strength mobilized along failure surface}}$$

or

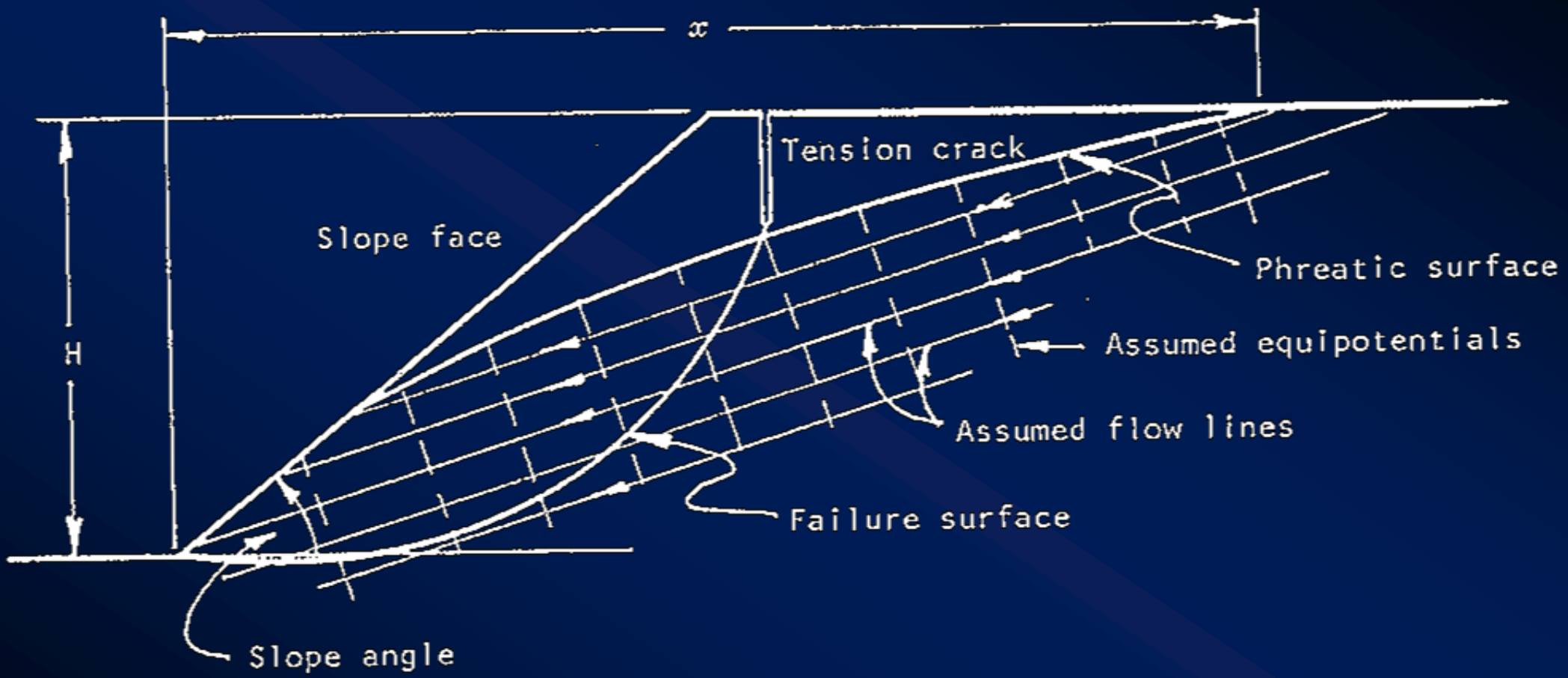
$$\tau_{mb} = \frac{c}{F} + \frac{\sigma \cdot \tan\phi}{F}$$

- *Iterative Analysis Required for Factor of Safety*

Circular Failure Design Charts - Assumptions

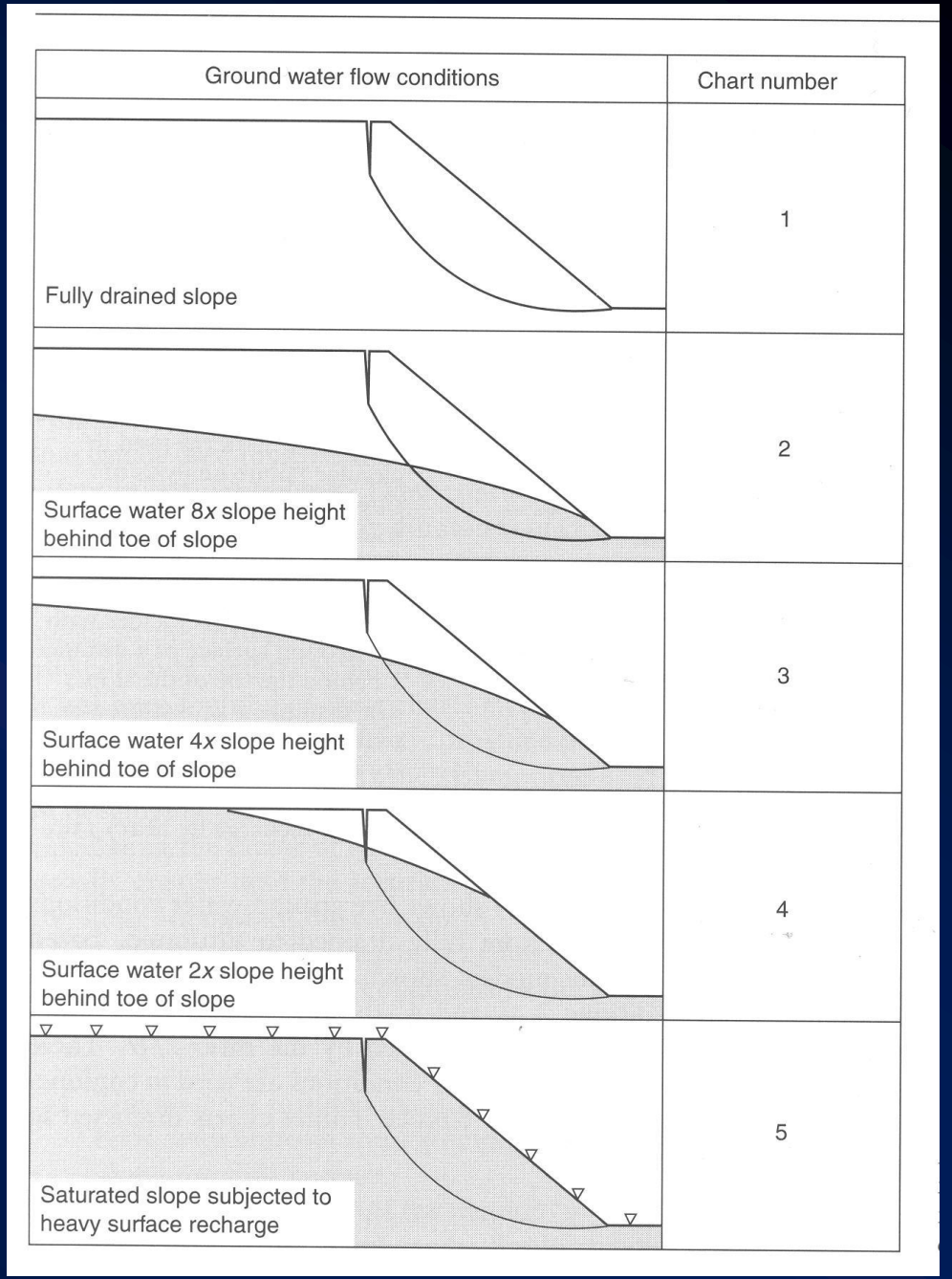
- Material Homogeneous with Uniform Shear Strength on Rupture Surface
- Shear Strength (τ) Defined by Cohesion (c) and Friction Angle (ϕ), $\tau = c + \sigma \tan \phi$
- Circular Rupture Surface, through Toe
- Vertical Tension Crack
- Rupture Surface for Minimum FOS
- Ground Water - no Perched Water Tables
- Material Density at 18.9 kN/cu. m.

Ground Water Flow Assumptions

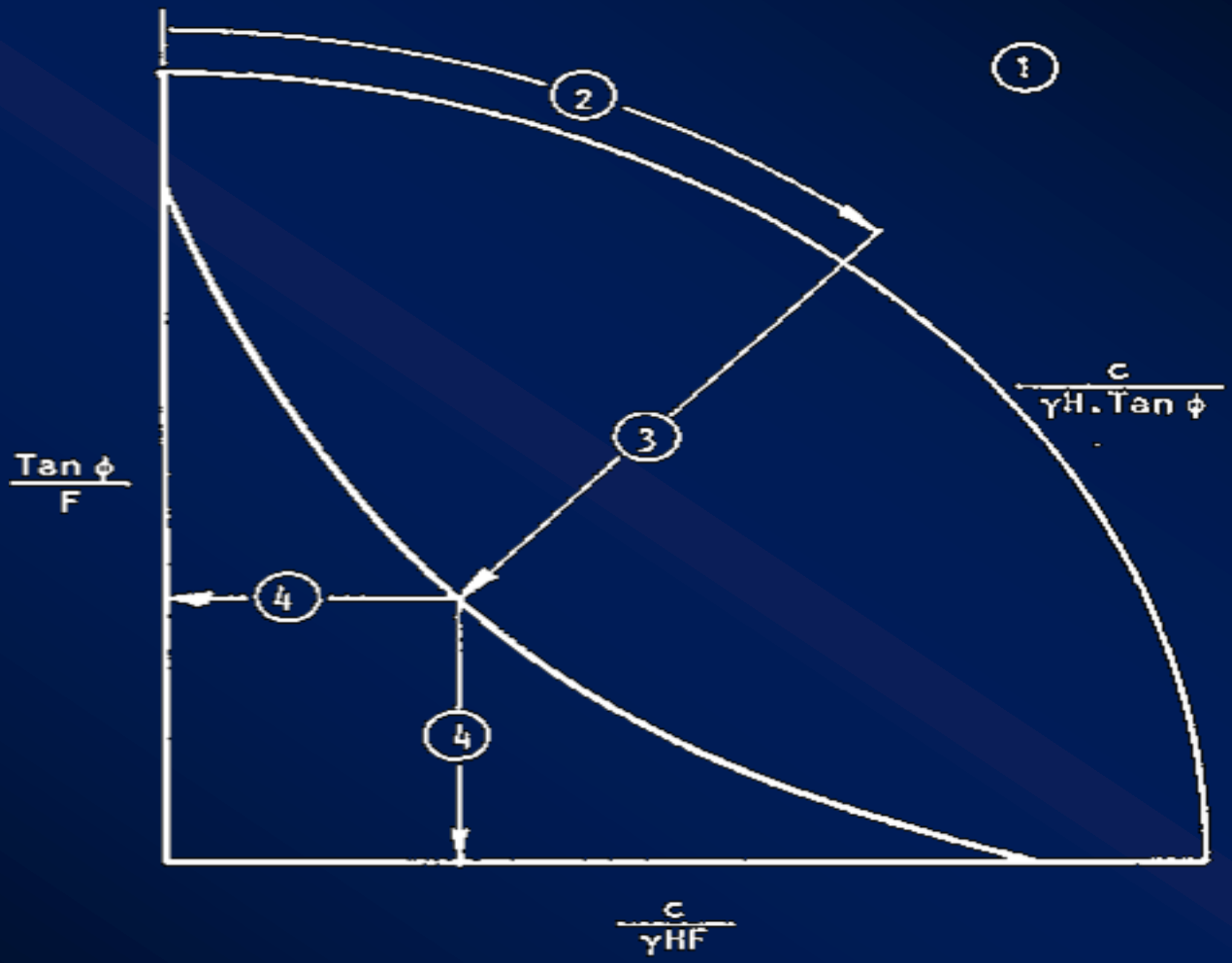


- *Water table intersects ground surface distance (x.H) behind crest*

Ground Water Flow Assumptions



Method of Analysis

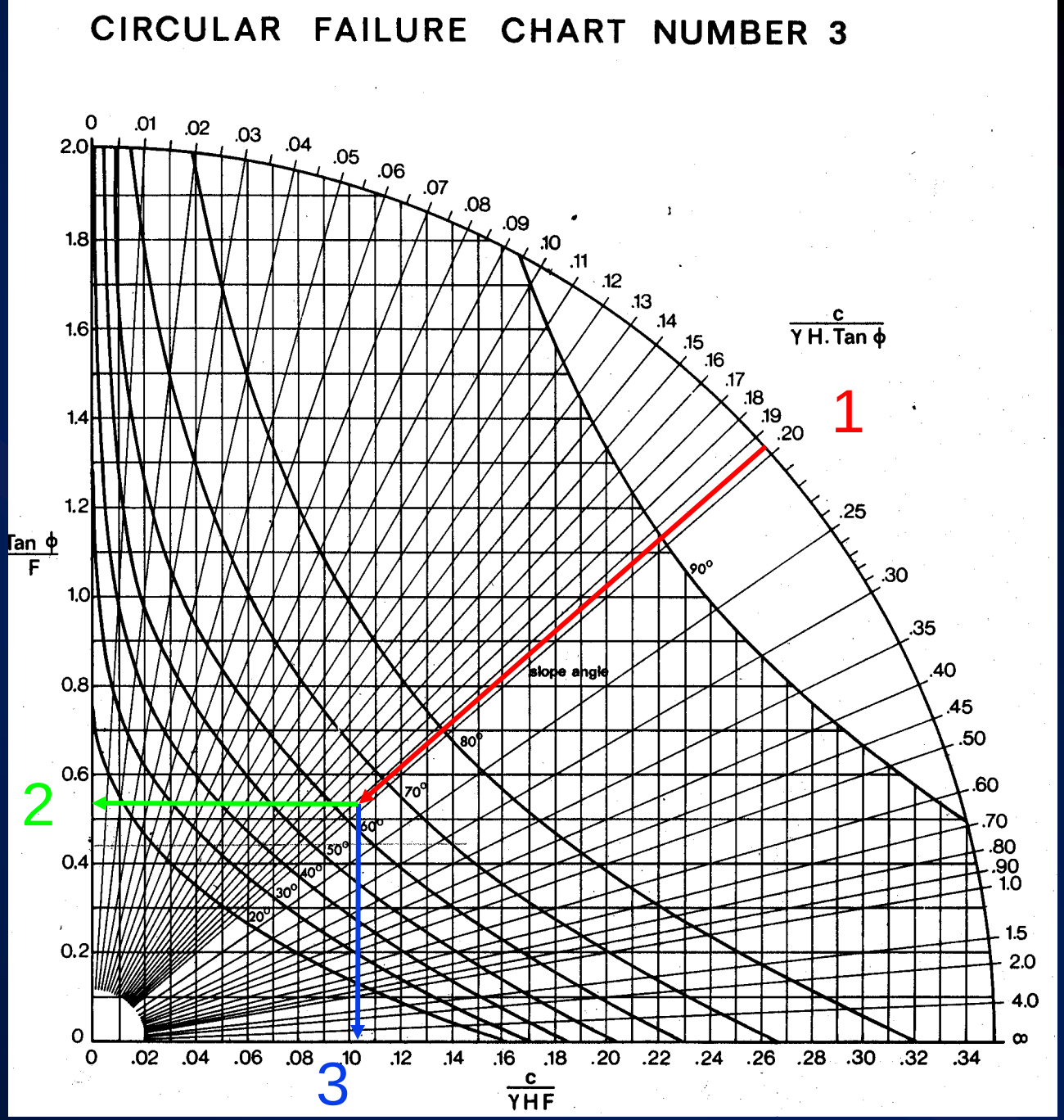


- Sequence of steps to find Factor of Safety

"Forward" Analysis

To determine Factor of Safety, F:

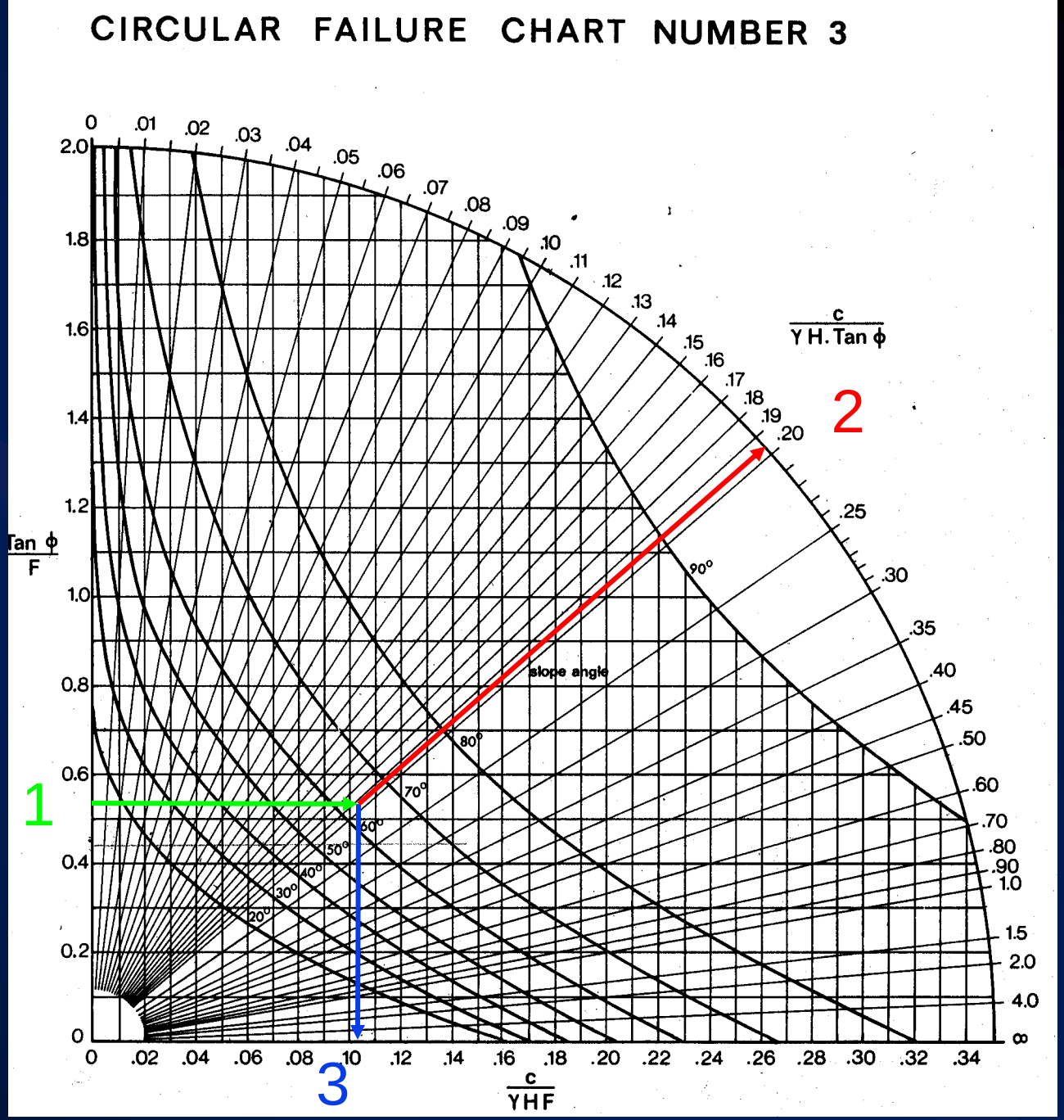
Known Values:
Strength parameters, Φ, c
Slope height, H
Slope angle, Ψ_f
Material density, γ



“Back” Analysis

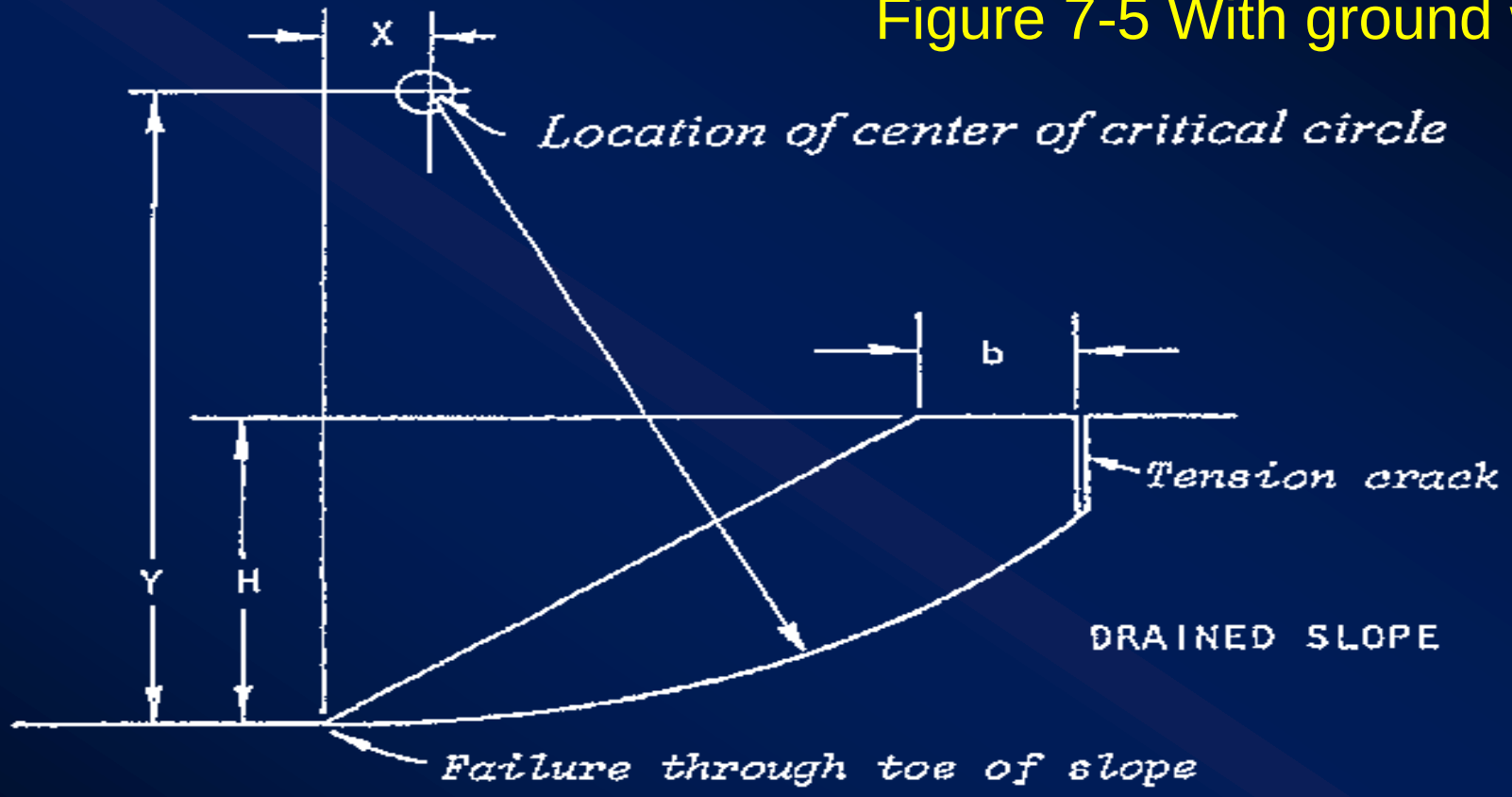
To determine Strength Parameters, Φ or c :

Known Values:
Factor of Safety, F
Slope height, H
Slope angle, Ψ_f
Material density, γ



Circular Failure - Location of Critical Failure Surface

Figure 7-4 Drained
Figure 7-5 With ground water

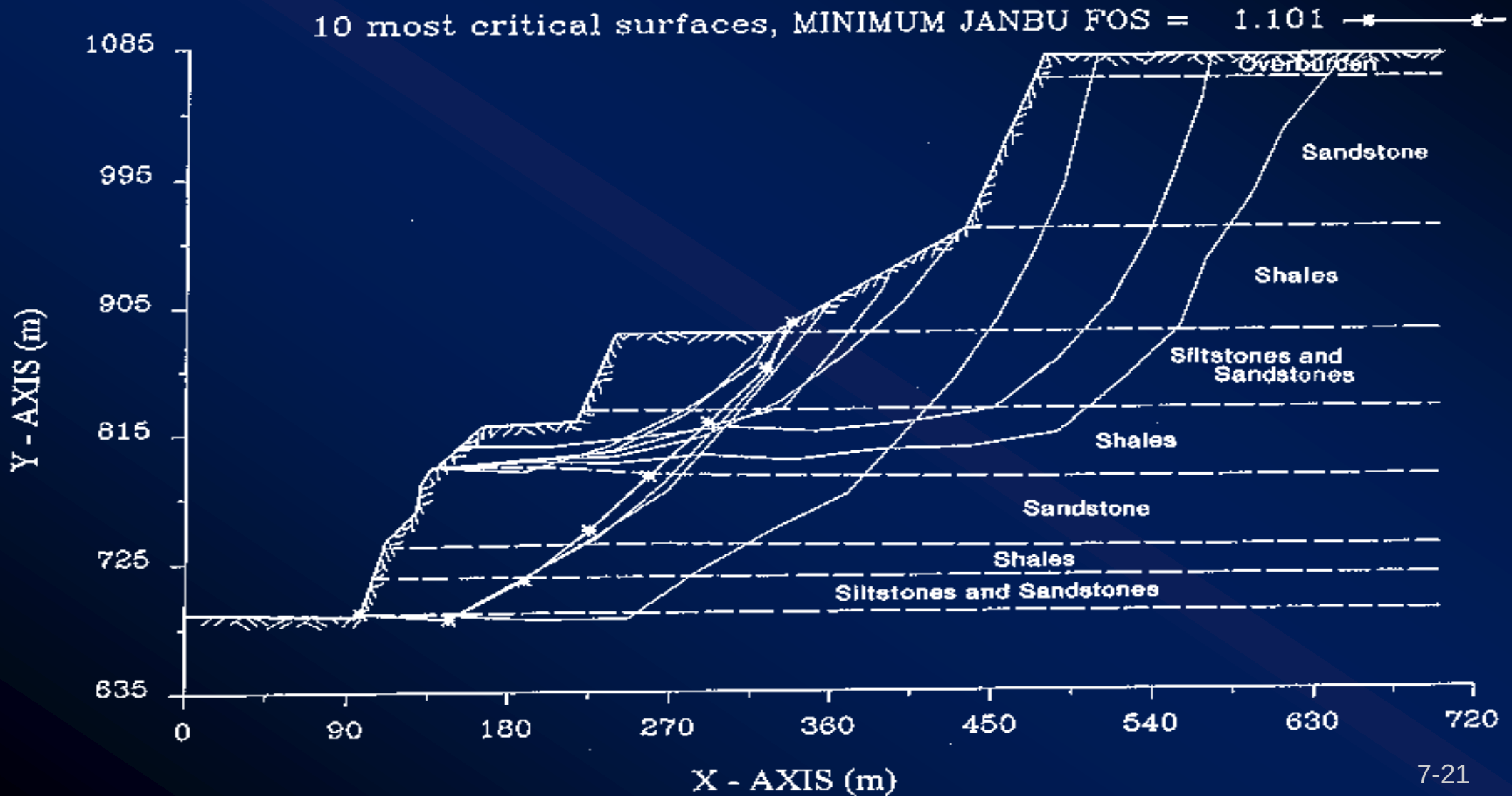


- ***Center of Circle defined by X,Y co-ordinates, Tension Crack by Distance b***

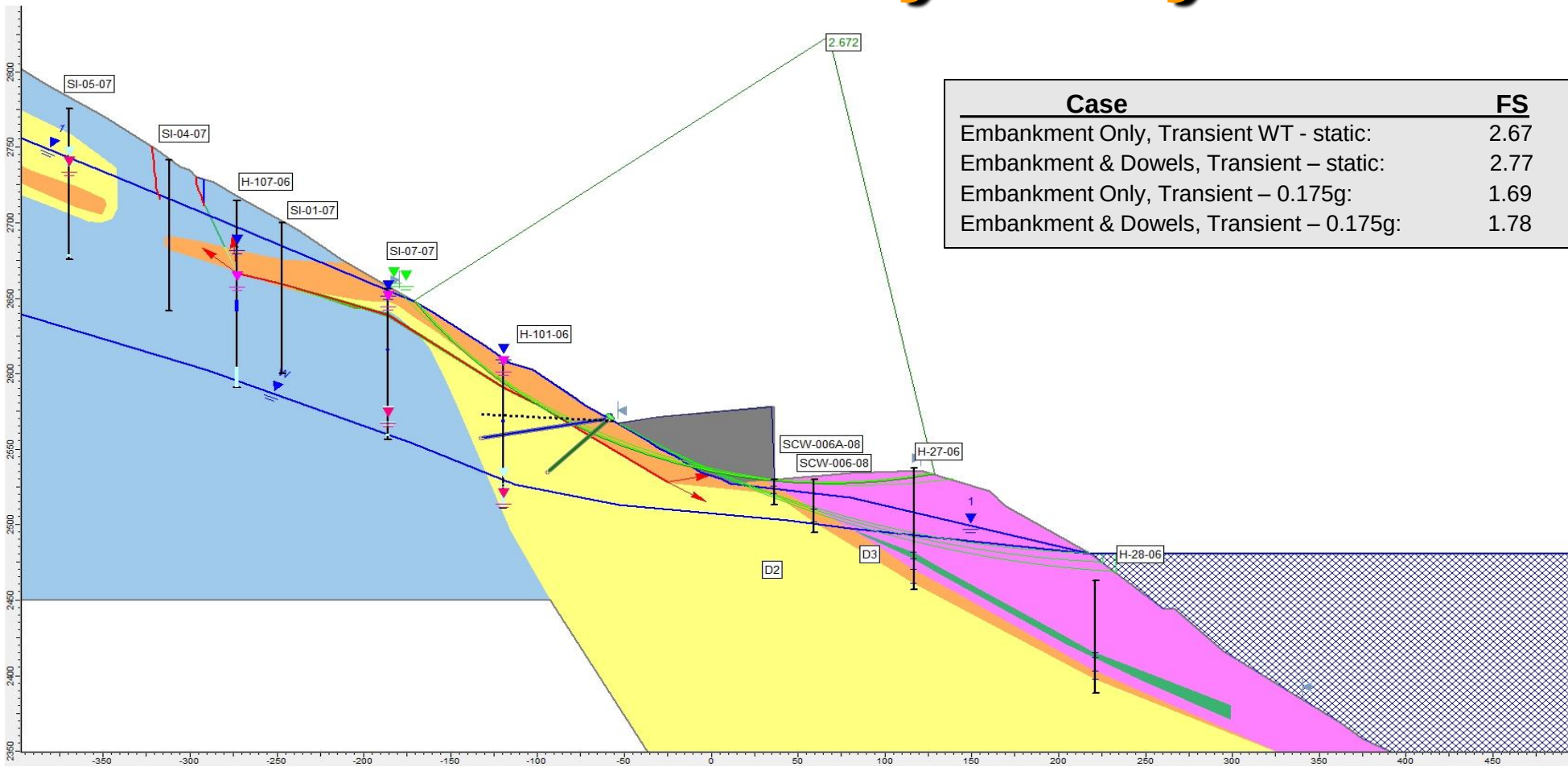
Circular Failure - Features of Two Dimensional XSTABL Analysis

- Slope Shape Defined
- Non-homogeneous materials
- Multiple Ground Water Tables
- Mohr-Coulomb or Hoek-Brown Strengths
- External Loads, e.g. Bridge Abutments
- Earthquake forces (pseudo-static)
- Failure Surface Shape Defined
- Deterministic Analysis

Circular Failure - Two Dimensional Stability Analysis



Example Circular Failure - Two Dimensional Stability Analysis

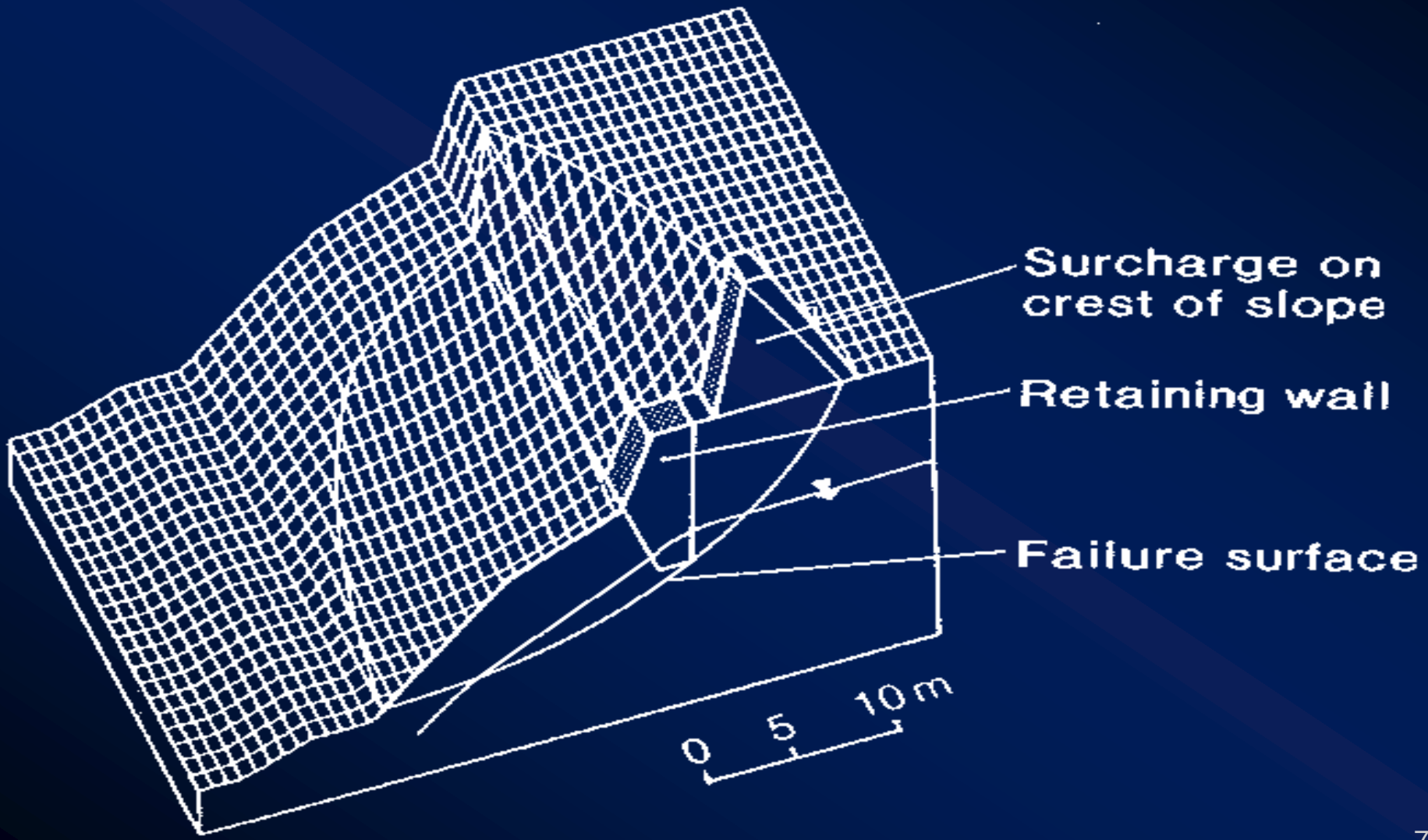


Case	FS
Embankment Only, Transient WT - static:	2.67
Embankment & Dowels, Transient – static:	2.77
Embankment Only, Transient – 0.175g:	1.69
Embankment & Dowels, Transient – 0.175g:	1.78

Figure 3

Median Wall Stability Analysis: Circular Failure with Embankment Soil

Circular Failure - Three Dimensional Stability Analysis



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